CLAIMS

1. A continuous-flow catalytic plate reactor for performing an endothermic reaction and an exothermic reaction in adjacent isolated reaction chambers to supply the heat required by said endothermic reaction by said exothermic reaction, comprising:

a) a stack of catalyst-coated platelets interleaved with transverse-flow plates, each of said catalyst-coated platelets and said transverse-flow plates comprising four apertures arranged in a spaced, substantially rectangular array and disposed as a first pair of apertures adjacent one end and a second pair of apertures adjacent a spaced, opposed end, all four apertures of one plate being aligned with all four apertures of all other plates of said stack;

b) each of said catalyst-coated platelets being impermeable to gas flow through said platelets and each having a coating of catalyst for said exothermic reaction on one side and a coating of catalyst for said endothermic reaction on the other side;

c) each of said transverse-flow plates includes a void region medial in said plate joining only one of said pairs of apertures to expose said catalyst coatings on both adjacent catalyst-coated platelets, which platelets form the side walls of said flow plate void region to define a reaction zone therebetween, said transverse-flow plates alternating between those in which said void region joins said first pair of apertures and those in which said void region joins said second pair of apertures;

d) said apertures and reaction zones defining two non-commingling flow paths through said stack;

e) the first of such flow paths extending from one of the aligned apertures of said first pair through the reaction zone of every second traverse-flow plate while passing over said coating of catalyst for said exothermic reaction to the remaining one of the first pair of aligned apertures; and

f) the second of such flow paths extending from one of the aligned apertures of said second pair through all remaining reaction zones while passing over said coating of catalyst for said endothermic reaction to the remaining one of the second pair of aligned apertures.

2. A continuous-flow catalytic plate reactor as in claim 1 in which said first pair of apertures is arranged diagonally in said rectangular array and said second pair of apertures is arranged diagonally in said rectangular array transverse to said first pair.

3. A continuous-flow catalytic plate reactor as in claim 1 in which one of said aligned apertures in each pair is defined as a feed channel and the remaining one of said aligned apertures in each pair is defined as a product channel, and wherein said feed channel is terminated by a flow stopping member to force flows from said feed channel through said reaction zone to said product channels

4. A continuous plate reactor as in claim 1 in which said catalyst-coated platelets are substantially thinner than said transverse-flow plates.

5. A continuous plate reactor as in 1 in which the void region of every traverse-flow is partially filled with means for redirecting gas flow into contact with at least some of said catalyst coated on said reaction zone side wall.

6. A continuous plate reactor as in claim 5 wherein said flow directing means comprises a groved metal plate.

7. A continuous plate reactor as in claim 5 wherein said flow directing means comprises metal or ceramic spheres.

8. A continuous plate reactor as in claim 1 wherein said separator platelets comprise an aluminum-containing iron alloy coated with catalyst.

9. A catalytic plate reactor as in claim 1 wherein said coating of catalyst for said exothermic reaction is a combustion catalyst, and said catalyst for said endothermic reaction is a steam reforming reaction catalyst

10. A method for performing an endothermic reaction and an exothermic reaction simultaneously in isolated adjacent reaction chambers to supply heat required for said endothermic reaction by said exothermic reaction, said method comprising:

a) passing an endothermic reaction feed gas stream and an exothermic reaction feed gas stream through a stack of generally planar reaction zones comprising catalyst-coated platelets interleaved with relieved transverse-flow plates, each of said catalyst-coated plates and said transverse-flow plates comprising four apertures arranged in a substantially rectangular array and defined as a first pair of apertures and a second pair of apertures, all four apertures of one plate being aligned with all four apertures of all other plates of said stack;

b) each of said catalyst-coated platelets being impermeable to gas flow other than through said apertures and each having a coating of catalyst for said exothermic reaction on one side and a coating of catalyst for said endothermic reaction on the other side;

c) each of said transverse-flow plates further comprising a void region medial thereof which joins only one of said pairs of apertures to expose said catalyst coatings on both adjacent catalyst-coated plates and form a reaction zone therein, said transverse-flow plates alternating between those in which said reaction zone joins said first pair of apertures and those in which said reaction zone joins said second pair of apertures;

d) said endothermic reaction feed stream and said exothermic reaction feed stream are fed through two non-commingling flow paths through said stack;

e) the first of such flow paths extending from one of said aligned apertures of said first pair through the reaction zone of every second transverse-flow plate while passing over said coatings of catalyst for said exothermic reaction to the remaining one of said aligned apertures of said first pair;

f) the second of such flow paths extending from one of said aligned apertures of said second pair through all remaining reaction zones while passing over said coatings of catalyst for said endothermic reaction to the remaining one of said aligned apertures of said second pair;

g) generating heat at said coatings of catalyst for said exothermic reaction and conducting said exothermic heat through said separator platelets directly to said coatings of catalyst for said endothermic reaction to accelerate said endothermic reaction.

11. A method in accordance with claim 10 in which said first pair of apertures is arranged diagonally in said rectangular array and said second pair of apertures is arranged diagonally in said rectangular array transverse to said first pair.

12. A method in accordance with claim 10 in which said exothermic reaction is a combustion reaction and said coating of catalyst for said exothermic reaction is a combustion catalyst, and said endothermic reaction is a steam reforming reaction and said catalyst for said endothermic reaction is a steam reforming reaction catalyst.

13. A method of producing a catalytic wall plate reactor comprising the steps of:

a) brazing two transverse-flow plates to opposite faces of a thin metal platelet to make a sub-assembly;

b) coating at least a portion of the exposed surface of one side of the thin metal platelet with a combustion catalyst;

c) coating at least a portion of the exposed surface of the opposite side of the thin metal plate with a reforming catalyst;

d) cleaning the exposed surfaces of the transverse-flow plates; and

e) brazing a stack of the subassemblies to form a plate reactor.

14. A method of producing a catalytic wall plate reactor comprising the steps of:

a) brazing a metal frame to each of opposite faces of a transverse-flow plate to make a sub-assembly;

b) coating at least a portion of one side of a thin metal platelet with a combustion catalyst;

c) coating at least a portion of the opposite side of the thin metal platelet with a reforming catalyst, said bi-catalyst coated platelet forming a separator platelet; and

d) forming a stack of catalyst coated platelets interleaved with said subassemblies, including placing inert, thermally resistant gaskets between the subassemblies and separator platelets.

15. A modular reactor sub-assembly for a continuous flow plate reactor

comprising in operative combination:

a) a separator platelet having a first surface and a second surface on the obverse side thereof, a longitudinal dimension terminating in first and second ends, and a lateral dimension generally orthogonal thereto terminating in first and second side edges;

b) said platelet having deposited on selected areas on at least one of said first and said second surfaces a coating of at least one catalyst compositions, said catalyst compositions being selected from the same or different compositions;

c) at least one first reactant gas flow plate disposed on said first side of said first separator plate;

d) at least one second reactant gas flow plate disposed on said second side of said first separator plate;

e) each of said first and second flow plates having a relieved area therein substantially corresponding to said selected catalyst composition coated area, said relieved area providing a generally planar reaction zone bounded on one side thereof by said separator platelet selected catalyst coating; and

f) said separator plate and said flow plates having aligned apertures generally located at apposed ends to provide passage of feedstock gases into and out of the respective reaction zones without short circuit and maintaining separate feed streams flow into and out of the respective zones, said gases flow in said reaction zones being selected from co-flow and counterflow.

16. A modular reactor subassembly as in claim 15 wherein said catalyst composition coating on said first platelet surface is different from said catalyst composition coating on said second platelet surface.

17. A modular reactor subassembly as in claim 16 wherein at least one of said flow plate reaction zones includes means for directing gas flow into contact with said catalyst coating separator plate surface.

18. A modular reactor subassembly for a continuous flow plate reactor comprising in operative combination:

a) at least one generally planar first reactant gas flow plate having a first face and a second face on the obverse side thereof, a longitudinal dimension terminating in first and second ends, and a lateral dimension generally orthogonal thereto terminating in first and second edges;

b) said at least one flow plate having a relieved area therein medial of said ends and edges, said area defining a generally planar reaction zone between said faces;

c) a first, generally planar separator platelet disposed on said first face of said flow plate and a second generally planar separator platelet disposed on said second face of said flow plate, said platelets defining side walls for said reaction zone;

d) said platelets each having a first surface and a second surface on the obverse side thereof; at least one of said first surfaces having deposited on selected areas a coating of at least one catalyst composition, said catalyst composition being selected from the same or different compositions and said selected areas of coating being aligned with and not extending beyond said flow plate reaction zone relieved area, and said first surfaces of said platelets on opposed faces of said flow plate facing each other with said at least one catalyst coated platelet area exposed in said reaction zone; and

e) said flow plate and said separator platelets having aligned apertures generally located at apposed ends to provide passage of feedstack gases into and out of said reaction zone.

19. A modular reactor subassembly as in claim 18 wherein both said first surfaces of said platelets are coated with the same catalyst composition.

20. A modular reactor subassembly as in claim 19 wherein both said second surfaces of said platelets are coated with the same catalyst composition, which composition is selected from the same or different catalysts as coated on said first surfaces of said platelets.

21. A modular reactor subassembly as in claim 19 wherein said flow plate reaction zone includes means for directing gas flow into contact with at least a portion of the catalyst composition on at least one of said first separator platelet surfaces.